A Modified Laboratory Canning Protocol for Bean that satisfies both the Canadian Legal Requirement and the U.S. Industry Standard

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Common bean (*Phaseolus vulgaris* L.), referred to as dry bean in North America, is the most widely grown food legume crop on a world-wide basis. Its production constitutes 32% of the total world food legume production (Hosfield, 1991). Dry bean crop in Canada is worth more than $60 million annually (Park and Buzzell, 1995). Much of the North American production of dry bean is processed into a canned product and the rest is used for home cooking. Consumer acceptability of the product depends primarily on its quality attributes and a poor quality cultivar (seed lot) will likely be rejected by both consumers and processors, regardless of how agronomically superior it is. Thus, dry bean lines must be evaluated for canning quality attributes before any are released as improved cultivars.

Canning quality in dry bean is determined by a complex of traits, viz., hydration coefficient (HC), washed drained weight (WDWT), percent washed drained weight (PWDWT - WDWT expressed as percentage by weight of the can contents), texture (TEXT), clumping (CL), appearance (AP), and color of dry seed, processed seed and cooked liquid. Evaluation of these traits (except PWDWT) is discussed by Hosfield and Uebersax (1980). Canning quality traits are influenced by several processing factors (Nordstrom and Sistrunk, 1979; Uebersax and Bedford, 1980), genotype (G), environment (E) and G x E interactions (Ghaderi *et al.,* 1984). Consumers view quality as a function of those attributes they can easily measure: clumping, appearance, flavor, color of the processed seed, and appearance of the brine. These traits have no legal requirement or industry standard. All other traits have either an industry standard (HC and TEXT) or a legal requirement (PWDWT) that should be met within given tolerances or limits (see below).

Pulses have been traditionally soaked either in cold water and/or hot water (blanching) prior to canning or home cooking. The amount of water imbibed by the seeds during soaking and blanching is quantified by the HC (weight of soaked bean seeds/weight of dry bean seeds). An HC of 1.8 to 2.0 is considered optimum by the industry and gives an indication of well-soaked beans (Nordstrom and Sistrunk, 1979; Hosfield, 1991). In the canneries, 206 g of soaked, blanched bean seed is weighed into each 14 fl oz (300 X 407) can. If a seed lot used to fill cans has a low HC (e.g., 1.6) relative to a seed lot with a high HC (e.g., 2.0), then a larger quantity of seeds from the former seed lot is needed to fill each can to attain the fill weight of 206 g, thereby resulting in a lower number of cans per tonne of dry seed. Thus, processors desire a high HC (1.8 or above).

The U.S. canning industry standard for TEXT of navy bean canned in brine is 72 kg force per 100 g of processed seed (Hosfield and Uebersax, 1980). The author is not aware of similar standards for TEXT in other bean classes. The Canada Agricultural Products Standards Act (1978) states that PWDWT should be no less than 60. Neither the U.S. canneries nor the USDA has any regulation for PWDWT. A high WDWT results in a high PWDWT. Also, a high HC prior to thermal processing results in a high PWDWT. However, PWDWT and TEXT are inversely related, and a compromise is required between these two traits.

These requirements make it difficult to develop dry bean cultivars that will yield a canned product with the desired combination of canning quality traits, including consumer preference.

Quality specialists have manipulated the calcium level in the soak water, blanch water and brine, as it has been implicated in toughening of the seed coat, thereby increasing TEXT, decreasing CL and improving the AP of the canned product. However, this is achieved with a sacrifice in HC, WDWT and PWDWT, since calcium has a negative effect on these traits. The minimum requirements for HC, TEXT and PWDWT can be met by weighing more bean seeds per can which will compensate for the decreased PWDWT brought about by increased calcium and the seeds will still have the desired TEXT. This is the basis of the laboratory canning protocol developed at Michigan State University (MSU) (Hosfield and Uebersax, 1980; Uebersax and Bedford, 1980). In this protocol, a fresh-mass equivalent of 100 or 115 g of seed solids per 15 oz (303 X 406) can is soaked and blanched in water containing 50 to 100 mg Ca kg^{-1}.

Canada has a quality regulation for PWDWT (≥ 60%), but not for TEXT. Therefore, the MSU canning protocol was modified to meet the Canadian quality regulation. Also, the means generated for canning quality traits by the modified laboratory protocol should reflect those processed using the industrial protocol, since most lots of bean seed will be canned commercially. The first change was to reduce the calcium level in the soak water, blanch water and brine to 10 mg Ca kg^{-1} if the bean seeds were soaked at room temperature for 30 min, followed by blanching at 88°C for 30 min. However, if the beans seeds were soaked at room temperature for 14 to 16 hours and blanched at 70°C for 3 minutes, then tap water (containing 22 to 25 mg Ca kg^{-1}) was used. The second change was to determine and use the minimum amount of total seed solids to meet the target 60 PWDWT in each commercial class. This was required because, i) seeds of each dry bean commercial class differ in size, shape, composition, texture of seed coat, etc., ii) processors are not willing to add an extra 10 to 20 g of soaked, blanched seed per can, and iii) weighing extra seeds per can will enable even poor quality samples to have PWDWT ≥ 60. Consequently, 96 g of seed solids per 14 fl oz (300 X 407) can for navy bean, 97 g for black bean, and 95 g for pinto bean was required for a PWDWT of 60 or higher.

This modified canning protocol successfully distinguish between good and poor quality cultivars, but resulted in poor TEXT for navy bean. The texture mean of the navy bean cultivars ranged from 37 to 57 kg force 100 g^{-1} of processed seed, in spite of the low calcium level (10 mg Ca kg^{-1}), but they met the target 60 PWDWT. While navy bean lines can be selected for high texture value in a breeding program, more study is needed on ways to manipulate the key canning quality traits: HC, WDWT, PWDWT and TEXT.

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